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PERFORMANCE SPECIFICATION

CHARGE, PROPELLING, 60MM, M235 FOR
MORTAR CARTRIDGES FOR THE 60MM M224 MORTAR SYSTEM

Prepared for
U.S. Army Armament Research Development & Engineering Center
Picatinny Arsenal, NJ 07806-5000

Prepared by
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FSC 1315

1. SCOPE

1.1 Scope. This specification covers requirements examinations and tests for a propelling charge designated as Charge, Propelling, 60mm, M235, for use on 60mm mortar cartridges.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are needed to meet the requirements specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all requirement documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein.

STANDARDS

DEPARTMENT OF DEFENSE

- MIL-STD-286C - Propellant, Solid: Sampling, Examination and Testing. (with Change Notice 1)
- MIL-STD-331B - Fuze and Fuze Components, Environmental and Performance Tests For (with Change Notice 6)
- MIL-STD-650 - Explosive: Sampling, Inspection and Testing (with Change Notice 6)
- MIL-STD-652D - Propellants, Solid, for Cannon, Requirements and Packing (with Change Notice 6)
- MIL-STD-1474C - Noise Limits for Army Materiel (with Change Notice 1)
- MIL-STD-1751 - Qualification Procedures for Explosives (High Explosive, Propellant and Pyrotechnics) (with Change Notice 3)
- MIL-STD-1916 - Department of Defense Test Method Standard DOD Preferred Methods for Accepting Product

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the DoD Single Stockage Point (DODSSP), Standardization Documents Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS (See 6.4)

US ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

PRODUCT DRAWINGS

9299245 - Support Assembly - Revision E
 9312697 - Container Assembly (Slurry) - Revision M,
 Reference only except for interface dimensions (See 3.3.2)
 11751196 - Fin, M27 - Revision F

(Copies of other Government documents, drawings and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the Contracting activity.)

TEST OPERATING PROCEDURES

ITOP 4-2-601 - Drop tests for Munitions
 ITOP 4-2-602 - Rough Handling Tests
 TOP 2-2-614 - Hazard Tests for Vehicles & Other Equipment
 TOP 4-2-822 - Electronic Measurement of Air Blast Overpressure

PUBLICATIONS

Bureau of Mines Report 5624

TB-700-2 - Department of Defense Explosive Hazard Classification

TM 9-1010-223-10 - Operator's Manual for the Lightweight Company Mortar 60MM, M224

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained. (See contract provisions for additional precedence criteria.)

3. REQUIREMENTS

3.1 Design verification/first article. When specified in the contract or purchase order (see 6.2), design verification and first article inspection and testing shall be conducted in accordance with the technical provisions herein (see 4.3).

3.2 Materials and manufacturing process. Unless otherwise specified; the design, materials and manufacturing process selection shall be the prerogative of the contractor as long as all articles submitted to the government fully meet the interface, ownership and support, environmental and operating requirements of this specification.

3.3 Interface requirements The M235 propelling charge shall accommodate the following interface requirements:

3.3.1 Weapon. The propelling charge when assembled to a 60mm mortar cartridge (M720, M888, M722, M721, XM767) shall be capable of being accurately and safely fired from a 60mm M224 mortar system.

3.3.2 Increment container dimensions. The propelling charge increment container shall conform to the following dimensional requirements:

<u>Dimension</u>	<u>Requirement</u>
Outside diameter	1.985 - .075 inches
Inside diameter	0.950 + .050 inches
Height	0.690 - .060 inches

3.3.3 Compatibility. All energetic materials utilized shall be compatible with all directly contacting materials (energetic and non-energetic). Non-energetic contacting materials include the M27 fin (Drawing 11751196 Revision F) and packing clip (Drawing 9299245 Revision E).

3.3.4 EOD procedures. Use of the M235 propelling charge shall not necessitate a change to the existing EOD procedures.

3.4 Ownership and support requirements. The M235 propelling charge shall possess the following life cycle ownership and support characteristics:

3.4.1 Life cycle. The propelling charge when assembled to a 60mm mortar cartridge and properly packaged shall be capable of meeting the performance specified herein after 2 years uncontrolled storage and twenty years controlled storage.

3.4.2 Stability. The propellant and increment container shall be stable for the life cycle of the 60mm mortar cartridge. Stability shall be considered met upon compliance with testing specified herein.

3.4.3 Qualification. The propellant shall be qualified for safety during transportation and manufacturing.

3.4.4 Transport safety.

3.4.4.1 Propellant. The propellant loaded in the M235 propelling charge shall comply with the following Hazard Classification when packaged in commercial packaging and tested IAW TB 700-2:

DOD Hazard Class/Div: 1.3C
DOD Hazard Compatibility Group: C
DOT Hazard Class: 1.3

3.4.4.2. Propelling charge. The Charge, Propelling, 60mm, M235 shall comply with the following Hazard Classification when packaged in commercial packaging and tested IAW TB 700-2:

DOD Hazard Class/Div: 1.3C
DOD Hazard Compatibility Group: C
DOT Hazard Class: 1.3
Net Explosive Weight: 8.5 grams

3.5 Environmental requirements. The M235 propelling charge shall be able to withstand the following environmental conditions:

3.5.1 Moisture resistance.

3.5.1.1 Hygroscopicity. The propellant shall not readily absorb moisture.

3.5.1.2 Water repellency. The propelling charge increment assembly shall not readily absorb moisture.

3.5.2 Cartridge level environmental requirements. The M235 propelling charge when assembled to a 60mm mortar cartridge shall be able to withstand the following environmental conditions and provide the cartridge with the required interior ballistics:

3.5.2.1 Hot-dry cycle. The propelling charge shall withstand a 7-day temperature cycle and subsequently be safe and provide sufficient impulse to assure the cartridge's ability to meet the ballistic requirements of 3.6.3. Testing shall be conducted with the cartridge in its unit pack configuration.

3.5.2.2 Cold soak. The propelling charge shall withstand a 3-day cold soak and subsequently be safe and provide sufficient impulse to assure the cartridge's ability to meet the ballistic requirements of 3.6.3. Testing shall be conducted with the cartridge in its unit pack configuration.

3.5.2.3 Sequential rough handling. The cartridge shall withstand the loose cargo vibration test (ITOP 4-2-602) phase of rough handling procedures and all rounds shall subsequently be safe and provide sufficient impulse to assure the cartridge's ability to meet the ballistic requirements of 3.6.3. Testing shall be conducted with the cartridge in its over pack configuration.

3.5.2.4 Adverse environment. The cartridge shall withstand a high humidity temperature cycle for twenty-eight days (MIL-STD-331, Test C1) with no significant degradation in ballistic performance specified in 3.6.3, and no evidence of discoloration (greening) of the increment container. Testing shall be conducted with the cartridge in its unit pack configuration.

3.5.3 Packaged drop. The M235 propelling charge when assembled to a 60mm mortar cartridge shall withstand a 12.2 meter drop without initiation of the propelling charge. Testing shall be conducted with the cartridge in its over pack configuration.

3.5.4 Environmental safety. The M235 propelling charge when assembled to a 60mm mortar cartridge shall comply with the following environmental safety requirements:

3.5.4.1 Blast overpressure (BOP). The BOP for 60mm mortar cartridges loaded with the M235 propelling charge shall not exceed 140 decibels (dB) within 51 meters of the gun position (TOP 4-2-820). The allowable number of rounds (ANOR) to be fired per day at charge 4 shall be at least 100 rounds (TOP 4-2-820).

3.5.4.2 Toxic fumes. The toxic fumes at the gun position of 60mm mortar cartridges loaded with M235 propelling charge shall not exceed the existing amount that results when firing 60mm mortar cartridges loaded with the M204 propelling charge (TOP 2-2-614).

3.6 Operational requirements.

3.6.1 Drop velocity. The propelling charge residue shall not cause hang-ups or slow drops of the mortar cartridge during firing. Use of the M235 shall not necessitate a change to the existing swabbing procedures for the M224 mortar system.

3.6.2 Charge adjustment flexibility. The propelling charge increment container shall be capable of withstanding charge adjustment onto an M27 fin (Drawing 11751196, Revision F) without damage.

3.6.3 Ballistics.

3.6.3.1 Firing tables. The propelling charge when assembled to a 60mm mortar cartridge shall provide the cartridge with a ballistic match to the existing firing tables developed when using the M204 propelling charge.

3.6.3.2 Rate of fire. The propelling charge when assembled to a 60mm mortar cartridge shall meet the following rate of fire requirements for the M224 mortar system:

TABLE I. Rate of fire requirements.

Parameter	Requirement
Maximum rate of fire for 1 min.	30 rounds/minute minimum
Sustained rate (10 minutes min.)	12 to 15 rounds/minute minimum

3.6.3.3 Interior ballistics. The propelling charge when assembled onto a 60mm mortar cartridge shall comply with the requirements defined in Table II:

TABLE II Ballistic performance requirements.

Characteristic	Temperature		
	-50°F	70°F	145°F
Muzzle velocity (mean)		795 +/- 13	
Muzzle velocity (standard deviation)		7.5	
Mean chamber pressure, max.		7580	8590
Individual chamber pressure, max.	10080	10080	10080
Individual velocity, min.	710	(772)	786
		8590	715
Velocity units - fps, Pressure units - psi			

3.6.4 Flash/smoke signature. During firing, the muzzle flash signature of 60mm mortar cartridges loaded with the M235 propelling charge shall not exceed the existing signature of these cartridges when loaded with the M204 propelling charge. Also, the smoke signature of the 60mm mortar cartridges loaded with the M235 shall not exceed the existing signature for these cartridges loaded with the M204.

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MEAN CHAMBER
PRESSURE



M224 - PROP
PRESSURE

M235

REQUIREMENTS/VERIFICATION CROSS REFERENCE MATRIX

METHOD OF VERIFICATION	CLASSES OF VERIFICATION
N/A Not Applicable	A - Design Verification
1 - Analysis	B - First Article
2 - Demonstration (End item test)	C - Production
3 - Examination	
4 - Test	

Section 3	Description	Verification Method				Verification Class			Section 4
Requirement		N/A	1	2	3	4	A	B	C
	<u>Interface requirements</u>								
3.3.1	Weapon			X			X	X	X
3.3.2	Increment dimensions				X		X	X	X
3.3.3	Compatibility				X		X		
3.3.4	EOD procedures			X			X		
	<u>Ownership and support requirements</u>								
3.4.1	Life cycle			X			X		
3.4.2	Stability				X		X	X	X
3.4.3	Qualification		X		X		X		
3.4.4.1	Hazard classification for propellant					X	X		
3.4.4.2	Hazard classification for the propelling charge					X	X		
	<u>Environmental requirements</u>								
3.5.1.1	Hygroscopicity					X	X	X	X
3.5.1.2	Water repellency					X	X	X	X
3.5.2.1	Hot-dry			X		X	X		
3.5.2.2	Cold soak			X		X	X		
3.5.2.3	Sequential rough handling (loose cargo)			X		X	X		
3.5.2.4	Adverse environment			X		X	X		
3.5.3	Packaged drop			X		X	X		
3.5.4.1	Blast overpressure		X	X			X		
3.5.4.2	Toxic fumes		X	X			X		

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Section 3	Description	Verification Method				Verification Class			Section 4
Requirement		N/A	1	2	3	4	A	B	C
	<u>Operating requirements</u>								
3.6.1	Drop velocity		X	X		X	X		4.5.5.1
3.6.2	Charge adjustment flexibility				X		X	X	4.5.5.2
3.6.3.1	Firing tables		X	X			X		4.5.5.3.1
3.6.3.2	Rate of fire			X			X		4.5.5.3.2
3.6.3.3	Interior ballistics			X			X	X	4.5.5.3.3
3.6.4	Flash/smoke signature		X	X			X		4.5.5.4

4. VERIFICATION

4.1 General provisions. The inspection (examinations and tests) herein shall be performed to determine whether or not the item conforms to the requirements in section 3 of this specification.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection and design verification testing (DVT) (see 4.3).

b. Conformance inspection (see 4.4).

4.3 First article inspection/DVT.

4.3.1 Design verification tests to be performed. The DVT quantity shall be subjected to the tests listed in Table III of this specification. The government may waive any or all design verification tests if the contractor provides data or evidence in his proposal that his design has successfully passed those tests.

4.3.2 First article submission. The contractor shall submit a first article sample as designated by the Contracting Officer for evaluation in accordance with provisions of 4.3.3. The first article sample shall consist of the assemblies, components and test specimens listed below in the quantities indicated in Table IV.

4.3.3 First article inspections to be performed. As determined by the Government, the first article assemblies, components and test specimens may be subjected to any or all of the examinations and tests specified in this specification (see Table IV).

4.3.4 Rejection. If any assembly, component or test specimen fails to comply with any of the applicable requirements, the design verification or first article sample shall be rejected. The Government reserves the right to terminate inspection upon any failure of an assembly, component or test specimen to comply with any of the requirements.

TABLE III. Design verification testing.**CLASSIFICATION OF CHARACTERISTICS**

PARAGRAPH	TITLE	SHEET 1 OF 1		DRAWING NUMBER
CLASSIFICATION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	NEXT HIGHER ASSEMBLY Inspection Method Reference
	<u>Interface requirements</u>			
	Weapon		3.3.1	4.5.2.1
	Increment dimensions	50	3.3.2	4.5.2.2
	Compatibility	5 g 1/	3.3.3	4.5.2.3
	EOD procedures	10	3.3.4	4.5.2.4
	<u>Ownership and support requirements</u>			
	Life cycle		3.4.1	4.5.3.1
	<u>Propellant stability</u>			
	Thermal stability	200 g	3.4.2	4.5.3.2.1
	Heat test	25 g	3.4.2	4.5.3.2.2
	Surveillance test	5 lbs	3.4.2	4.5.3.2.3
	Propelling charge increment stability	5	3.4.2	4.5.3.2.4
	<u>Propellant qualification</u>		3.4.3	4.5.3.3
	Hazard classification for propellant		3.4.4.1	4.5.3.4
	Hazard classification for the propelling charge		3.4.4.2	4.5.3.5
	<u>Environmental requirements</u>			
	Hygroscopicity	100 g	3.5.1.1	4.5.4.1.1
	Water repellency	25	3.5.1.2	4.5.4.1.2
	Hot-dry	32	3.5.2.1	4.5.4.2.1
	Cold soak	32	3.5.2.2	4.5.4.2.2
	Sequential rough handling (loose cargo)	64	3.5.2.3	4.5.4.2.3
	Adverse environment	24	3.5.2.4	4.5.4.2.4
	Packaged drop	24	3.5.3	4.5.4.3
	Blast overpressure	60	3.5.4.1	4.5.4.4.1
	Toxic fumes	120 2/	3.5.4.2	4.5.4.4.2
	<u>Operating requirements</u>			
	Drop velocity		3.6.1	4.5.5.1
	Charge adjustment flexibility	50	3.6.2	4.5.5.2
	Firing tables	75	3.6.3.1	4.5.5.3.1
	Rate of fire	260	3.6.3.2	4.5.5.3.2
	Interior ballistics	70	3.6.3.3	4.5.5.3.3
	Flash/smoke signature		3.6.4	4.5.5.4
NOTES:				
1/ 5 g each of propellant and increment container assembly.				
2/ This test may be combined with the rate of fire test.				

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4.4 Conformance inspection.

4.4.1 Inspection lot formation. The term "inspection lot" is defined as a homogeneous collection of units of product from which a representative sample is drawn or which is inspected 100 percent to determine conformance with applicable requirements. Units of product selected for inspection shall represent only the inspection lot from which they are drawn and shall not be construed to represent any prior or subsequent quantities presented for inspection. Homogeneity shall be considered to exist provided the inspection lot has been produced by one manufacturer, in one unchanged process, using the same materials and methods, in accordance with the same drawings, same drawing revisions, same specifications and same specification revisions. All material submitted for inspection in accordance with this specification shall comply with the homogeneity criteria specified herein, regardless of the type of inspection procedure, which is being applied to determine conformance with requirements. Each inspection lot of propelling charges shall contain:

a. Propelling charge increment assemblies of one lot interfix from one manufacturer.

b. Propellant from not more than one lot from one manufacturer.

4.4.2 Examinations and tests.

a. Classification of characteristics. Quality conformance examinations and tests are specified in the following Classification of Characteristics paragraphs. The contractor's quality program or detailed inspection system shall provide assurance of compliance of all characteristics with the applicable drawing and specification requirements utilizing as a minimum the conformance criteria specified. Acceptance of product shall be accordance with MIL-STD-1916. Defect classification definitions are defined in MIL-STD-1916.

b. Alternative quality conformance provisions. Unless otherwise specified herein or provided for in the contract, alternative quality conformance procedures, methods or equipment, such as statistical process control, tool control, variables sampling or other types of sampling plans, etc., may be used by the contractor when they provide, as a minimum, the level of quality assurance required by the provisions herein. Prior to applying such alternative procedures, methods or equipment, the contractor shall describe them in a written proposal submitted to the Government for evaluation (see 6.5). When required, the contractor shall demonstrate that the effectiveness of each proposed alternative is equal to or better than the specified quality conformance provision(s) herein. In case of dispute as to whether the contractor's proposed alternative(s) provides equivalent assurance, the provisions of this specification shall apply. All approved alternative provisions shall be specifically incorporated into the contractor's quality program or inspection system, as applicable.

CONFORMANCE REQUIREMENTS
CLASSIFICATION OF CHARACTERISTICS

PARAGRAPH	TITLE	SHEET 1 OF 1		DRAWING NUMBER
4.4.2.1	Propellant			
CLASSIFICATION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	Inspection Method Reference
Critical				
1	Stability			
	Thermal stability	200 g	3.4.2	4.5.3.2.1
	Heat test	25 g	3.4.2	4.5.3.2.2
	Surveillance test	5 lbs	3.4.2	4.5.3.2.3
NOTES:				

CONFORMANCE REQUIREMENTS
CLASSIFICATION OF CHARACTERISTICS

PARAGRAPH	TITLE	SHEET 1 OF 1		DRAWING NUMBER
4.4.2.2	Propelling Charge Increment Container			
CLASSIFICATION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	NEXT HIGHER ASSEMBLY Inspection Method Reference
<u>Critical</u>				
1	Stability	5	3.4.2	4.5.3.2.4
<u>Major</u>				
101	Outside diameter	Level IV	3.3.2	Gage
102	Inside diameter	Level IV	3.3.2	Gage
103	Height	Level IV	3.3.2	Gage
104	Water repellency test	25	3.5.1.2	4.5.4.1.2
105	Charge adjustment flexibility test	50	3.6.2	4.5.5.2
NOTES:				

CONFORMANCE REQUIREMENTS
CLASSIFICATION OF CHARACTERISTICS

PARAGRAPH	TITLE	SHEET 1 OF 1		DRAWING NUMBER
4.4.2.3	Charge, Propelling			
CLASSIFICATION	EXAMINATION OR TEST	CONFORMANCE CRITERIA	REQUIREMENT PARAGRAPH	NEXT HIGHER ASSEMBLY Inspection Method Reference
<u>Critical</u>				
1	Container or container seal damaged to the extent that propellant will escape	100%	3.5.2.3	Visual
2	Weight of propellant in excess of three grains below minimum	100%	3.5.2.3	Gage
<u>Major</u>				
101	Weight of propellant	100%	3.5.2.3	Gage
102	Container or container seal damaged but not to the extent that propellant will escape	100%	3.5.2.3	Visual
	Proving ground test			
	Interior ballistic evaluation	280 (70 Ctgs)	3.6.3.3	4.5.5.3.3
NOTES:				

4.4.3 Testing.

4.4.3.1 Preproduction sample/propellant testing. Ballistic testing of preproduction and production propellant lots may be helpful in determining proper propellant charge weights in the M235 propelling charge. An aging period of 45-60 days is recommended prior to ballistic testing of propellant. ; . -

4.4.4 Inspection equipment. The inspection equipment required to perform the inspections specified herein is identified in the "Inspection Method Reference" column of the Classification of Characteristics listings starting with 4.4.2.1. Contractor inspection equipment designs shall be submitted for Government approval as specified in the contract. Designs which provide variable measurements instead of attributes data are preferred in order to facilitate the use of statistical process control. Inspection of critical characteristics that require gaging shall be performed by non-operator dependent, repeatable, automatic decision making inspection systems. The manufacturing and inspection system shall assure no more than one (1) critical defect per million items produced. See 6.3 herein.

4.5 Methods of inspection.

4.5.1 Verification alternatives. Alternate test methods, techniques or equipment, including the application of statistical process control, tool control, or cost effective sampling may be proposed by the contractor.

4.5.2 Interface evaluations.

4.5.2.1 Weapon. This requirement is considered met upon successful completion of ballistic tests.

4.5.2.2 Increment dimensions. This requirement is considered met upon successful inspection of the required dimensions.

4.5.2.3 Compatibility testing. Compatibility testing of the propellant/container interface shall be performed by the contractor. Method 408.1 of MIL-STD-286 shall be performed. The criteria used for acceptance shall be negligible reactivity.

4.5.2.4 EOD testing. The cartridges shall be subjected to the standard EOD test for 60mm mortar cartridges. Specific guidance for test requirements or methods shall be directed to the government technical agency. The quantity of cartridges represented by the sample shall be rejected if the test results do not comply with the requirements.

4.5.3 Ownership and support evaluations.

4.5.3.1 Life cycle. This requirement is considered met upon successful completion of required verification testing and certificate of conformance from the Contractor.

4.5.3.2 Propellant stability.

4.5.3.2.1 Thermal stability. A sample of 200 g shall be selected for this test. When tested in accordance with Method 407.1 of MIL-STD-286, no visible fumes shall be generated by the propellant in less than 30 days when stored at 65.5 °C.

4.5.3.2.2 Heat test. A 25 g propellant sample from every propellant lot shall be subjected to the heat test in accordance with MIL-STD-286, Method 404.1 at the conditions defined below.

4.5.3.2.2.1 Single base propellants. Methyl violet paper shall not change to a salmon pink in less than 40 minutes and the propellant shall not explode in less than 5 hours when subjected to a temperature of 134.5 °C.

4.5.3.2.2.2 Double and triple base propellants. Methyl violet paper shall not change to salmon pink in less than 40 minutes and no fumes shall be given off by the propellant in less than 1 hour when subjected to a temperature of 120 °C.

4.5.3.2.3 Surveillance testing. A 5 pound sample of each production lot shall be subjected to surveillance testing (see 6.6). Testing shall be conducted in accordance with MIL-STD-652.

4.5.3.2.4 Propelling charge increment stability. Samples shall be tested in accordance with MIL-STD-286, Method 404.1 using a temperature of 134.5°C. The propelling charge increment assembly shall not completely change the color of the methyl violet paper to salmon pink in less than thirty five minutes.

4.5.3.3 Qualification of energetic materials. The following tests are required to qualify the new propellant and are part of design verification testing.

4.5.3.3.1 Transportation safety.

4.5.3.3.1.1 Impact sensitivity (apparatus & comparison values). The test shall be conducted in accordance with chapter 5.2.2, 5.4.2 or 5.5.1 of MIL-STD-1751. There shall be no reaction at a height of 3 inches.

4.5.3.3.1.2 Ignition & unconfined burning. The test shall be conducted in accordance with test 5.2g of TB-700-2. The propellant shall be accepted if the propellant only burns.

4.5.3.3.1.3 Thermal stability. The test shall be conducted in accordance with test 5.2h of TB-700-2. The propellant shall be accepted if no out gassing occurs.

4.5.3.3.1.4 Card gap. The test shall be conducted in accordance with test 5.2j of TB-700-2. The propellant shall be accepted if the card gap is less than or equal to 70 cards. If the results are greater than 70 cards, the hazard classification testing (stack and burn test) shall be used to determine compliance to this requirement.

4.5.3.3.2 Manufacturing safety.

4.5.3.3.2.1 Friction sensitivity (apparatus & comparison values). The test shall be conducted in accordance with chapter 5.4.8 or 5.5.3 of TB 700-2.

4.5.3.3.2.2 Electrostatic sensitivity (apparatus & comparison values). The test shall be conducted in accordance with chapter 5.2.3, 5.4.7 or 5.5.4 of MIL-STD-1751.

4.5.3.3.2.3 Autoignition temperature. The test shall be conducted in accordance with chapter 5.3.9 of MIL-STD-1751.

4.5.3.3.2.4 Explosion temperature (5 seconds). The test shall be conducted in accordance with method 506.1 of MIL-STD-650.

4.5.3.3.2.5 Explodability of du
concentration test shall be conducted
of BOM Report 5624.

The minimum explosive
accordance with page 12

4.5.3.3.2.6 Detonation. The test shall be conducted in
accordance with test 5.2f of TB-700-2.

4.5.3.3.2.7 ERL impact (type 12, 2.5 kg weight). The test
shall be conducted in accordance with method 511.1 of MIL-STD-
650.

4.5.3.4 Hazard classification testing for the propellant.
The test items shall be subjected to testing described in Chapter
5 of TB 700-2. Specific guidance for test requirements or
methods shall be directed to the government technical agency.
The quantity of cartridges represented by the sample shall be
rejected if the test results do not comply with the requirements.

4.5.3.5 Hazard classification testing for the propelling
charge. The test items shall be subjected to testing described
in Chapter 5 of TB 700-2. Specific guidance for test
requirements or methods shall be directed to the government
technical agency. The quantity of cartridges represented by the
sample shall be rejected if the test results do not comply with
the requirements.

4.5.4 Environmental evaluations.

4.5.4.1 Moisture resistance.

4.5.4.1.1 Hygroscopicity. A sample of the design
verification propellant lot and the first production lot shall be
tested for hygroscopicity. The 100 g test samples shall be
randomly selected and subjected to the testing specified in
Method 503.1.3 of MIL-STD-286. The lot shall be rejected if the
value of the hygroscopicity exceeds 2.15%.

4.5.4.1.2 Water repellency. The container assemblies shall
be tested for water repellency by a brief immersion in water (1-2
seconds). The parts shall be examined for "beading" or non-
wetting. The container assemblies shall be rejected if any part
shows a lack of beading or incomplete moisture protection.

4.5.4.2 Cartridge level environmental evaluations.

4.5.4.2.1. Hot dry cycle. The test cartridges shall be
subjected to seven cycles of the low humidity/high temperature
schedule in Table V. After the seventh cycle, the rounds shall
be visually inspected for safety defects. After inspection, the
rounds shall be repacked, conditioned to 145°F for a period of 24
hours, minimum, and fired as specified in 4.5.4.2.5. If one or
more safety defects occur, the quantity of propelling charges
represented by the sample shall be rejected.

TABLE V. Low-humidity/high temperature cycle (24 hours).

Hour	Temp		Relative Humidity, Percent
	°C	°F	
1	35	95	10
2	34	94	10
3	34	94	10
4	33	92	10
5	33	92	10
6	33	91	10
7	36	97	10
8	40	104	5
9	44	111	5
10	51	124	5
11	56	133	5
12	63	145	5
13	69	156	<5
14	70	158	<5
15	71	160	<5
16	70	158	<5
17	67	153	<5
18	63	145	5
19	55	131	5
20	48	118	5
21	41	105	10
22	39	103	10
23	37	99	10
24	35	95	10

4.5.4.2.2 Cold soak testing. The test cartridges in unit packs shall be conditioned to -60°F for three days. Following the cold soak, the rounds shall be visually inspected for safety defects. After inspection, the rounds shall be repacked, conditioned to -50°F for 24 hours, minimum, and fired as specified in 4.5.4.2.5. If one or more safety defects occur, the quantity of propelling charges represented by the sample shall be rejected.

4.5.4.2.3 Sequential rough handling (loose cargo). The test cartridges shall be divided into two groups. One group shall be conditioned to -50°F for 24 hours, minimum. The other group shall be conditioned to 145°F for 24 hours, minimum. Each group shall be subjected to the testing outlined in ITOP 4-2-602. After the loose cargo test the packaging shall be inspected and damage recorded. After the test, the cartridges shall be inspected for safety defects and damage. Following the inspection, the rounds shall be repacked, conditioned to -50°F or 145°F as appropriate, and fired as specified in 4.5.4.2.5. If

one or more safety defects occur, the quantity of propelling charges represented by the sample shall be rejected.

4.5.4.2.4 Adverse environment testing. The 16 test cartridges in unit packs shall be subjected to the high humidity/temperature cycling test specified in MIL-STD-331, Test C1. Following the exposure, the rounds shall be visually examined for degradation. The rounds shall be dried at ambient conditions for 48 hours, minimum, reinspected and fired as specified in 4.5.4.2.5.

4.5.4.2.5 Ballistics. The rounds shall be fired at maximum charge from a 60mm M224 Mortar at a tube elevation of 1156 mils. The mortar tube shall be swabbed in accordance with the manual. Muzzle velocity and chamber pressure shall be recorded for each test round. The mean velocity and mean chamber pressure shall be calculated.

The quantity of propelling charges represented by the sample shall be rejected if:

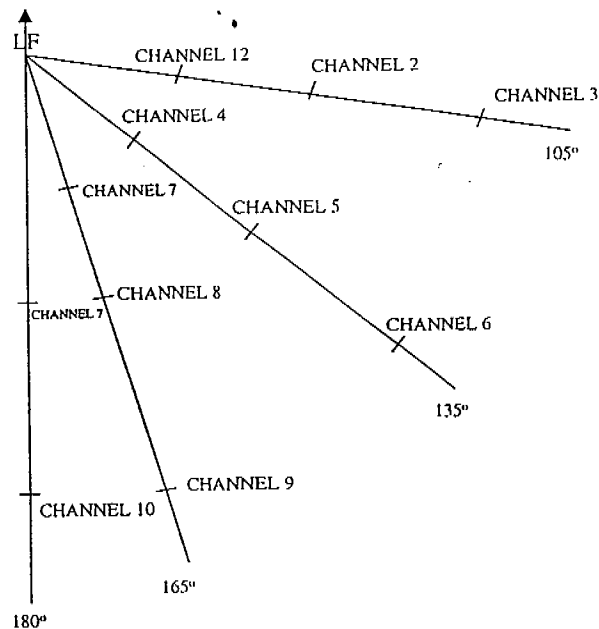
- a. An individual pressure exceeds the maximum requirement.
- b. An individual pressure is below the minimum requirement

4.5.4.3 Packaged drop. The test cartridges shall be divided into two groups. One group (two overpacks) shall be conditioned to -60°F for 24 hours, minimum. The other group shall be conditioned to 145°F for 24 hours, minimum. All test cartridges shall be tested in accordance with ITOP 4-2-601. If one or more safety defects occur, the quantity of cartridges represented by the sample shall be rejected.

4.5.4.4 Environmental safety evaluations.

4.5.4.4.1 Blast overpressure. The cartridge integrated propelling charges shall be fired from a M224 mortar system in a flat area free of gravel/rocks and clear of any structure that could cause reflection within a 15 meter radius of the mortar setup. Piezoelectric transducers (Pcb blast gauges) shall be placed radially around the weapon with the muzzle placed at the transducer grid center with the mortar elevated to the test elevation. The 180° line shall coincide with the axis of the barrel with the line of fire in the 0° direction. All transducers shall be mounted at a height of 0.9 meter (to the center of sensitive element) and positioned as illustrated in Figure 1. The transducers shall be aligned with the plane of the sensitive element passing through the axis of the barrel of the weapon with the sensitive element up. Two microphones positioned at a height of 1.5 meters shall be placed on the 135° radial, at distances of 40 and 60 meters from the weapon muzzle for Charge 4

FIGURE 1 - BLAST OVERPRESSURE TRANSDUCER LOCATIONS



or 30 and 50 meters for Charge 3. Atmospheric pressure and temperature during firing shall be recorded. The test shall not be conducted at wind speeds above 12 mph. Rounds shall be fired as specified in Table VII.

TABLE VII Blastoverpressure test matrix.

CHARGE	QUADRANT ELEVATION					
	800 MILS		1156 MILS		1511 MILS	
	M235	M204	M235	M204	M235	M204
3			10	10	10	10
4	10	10				

Maximum chamber pressure and muzzle velocity shall be recorded for each round fired. The peak muzzle blast overpressure and the B-duration data associated with each peak pressure shall be recorded with each round. The allowable number of rounds per day (ANOR/day) shall be calculated in accordance with MIL-STD-1474 and recorded. Microphone readings shall be

used to determine the location of the minimum distance to the 140dB level. The quantity of propelling represented by the sample shall be rejected if:

- a. The M235 ANOR exceeds the ANOR requirement.
- b. The 140 dB location is closer than 51 meters.

The test result evaluation shall be referred to the government technical agency if the M204 test rounds fail to meet any of the requirements.

4.5.4.4.2 Toxic fumes testing. Two groups of sixty rounds each shall be fired at maximum charge from a M224 mortar system at a weapon elevation of 800 mils. One group shall be assembled with the M235 and the other with the M204. The rounds shall be fired at a sustained rate of fire (20 round per minute). After a steady rate of propellant gases are obtained around the gun position, air-sampling bags/analyzers (as required) shall be used to collect the test samples/data at the expected head positions of the gun crew for each type of propelling charge. The ammonia (NH3), carbon monoxide (CO), nitric oxide (NO), sulfur dioxide (SO2) and nitrogen dioxide (NO2) levels shall be determined from the test samples. The quantity of M235 propelling charges shall be rejected if the toxic fumes levels for the M235 propelling charge are significantly different than the M204 propelling charge results. If the results are inconclusive, the data shall be forwarded to the technical agency for evaluation.

4.5.5 Operating requirement evaluations.

4.5.5.1 Drop velocity testing. Drop velocity data shall be collected during the firing tables testing (4.5.5.3.1). The data for each charge at a quadrant elevation of 800 mils shall be combined and the mean and standard deviation shall be calculated for the test and standard 60mm cartridges. The M235 drop velocity distribution shall not be statistically different than the M204.

4.5.5.2 Charge adjustment flexibility test. The container assemblies shall be tested for the flexibility needed to adjust mortar charges in the field. The container assemblies shall be examined for any defects prior to the test. The test containers shall be positioned on and removed two times from a solid bar of the maximum allowable outside diameter of the M27 fin. The "snap" on and off the simulated fin gage shall be performed with the container assembly oriented perpendicular to the fin gage. After removal, the container assembly shall be examined for cracks, rips, tears, open seam (if applicable), crush ends and fold/creases in the container material. The containers shall be rejected if any damage occurs.

4.5.5.3 Ballistic evaluation.

4.5.5.3.1 Firing tables. The M235/M204 propelling charges shall be assembled to M720 mortar cartridges, conditioned to 70°F for 24 hours and fired as specified in Table VI.

TABLE VI Firing tables testing.

CHARGE	QUADRANT ELEVATION					
	800 MILS		1156 MILS		1511 MILS	
	M235	M204	M235	M204	M235	M204
1	5	5	5	5	5	5
2	5	5	5	5	5	5
3	5	5	5	5	5	5
4	5	5	5	5	5	5

The rounds shall be fired from a 60mm M224 mortar at the specified true elevations. The mortar shall be swabbed in accordance with the manual. Each group shall be fired in alternating sequence (one M235, one M204, one M235, etc.). All cartridges within any group shall be fired along the same line of fire on the same occasion (four-hour period or period of similar meteorological conditions). Cartridge as-fired weight, muzzle velocity, chamber pressure, range, deflection, fuze functioning and time of flight shall be recorded for each test round. Drop velocities shall be recorded for each round fired. A tracking radar shall be used during the test. Smear camera photos or equivalent shall be obtained at a slant range of six (6) meters. Meteorological data shall be measured before and after each group of rounds fired. Contingency rounds shall be available if range data is not obtained for a test round. The following shall be calculated for each group:

- Mean velocity and standard deviation
- Mean range and standard deviation
- Probable error in range and deflection.

The quantity of propelling charges represented by the sample shall be rejected if:

- One or more prematures occur
- One or more metal parts failures occur
- One or more short rounds occur
- The M235 is not ballistically matched to the M204 at all charges and elevations.

4.5.5.3.2 Rate of fire and cook-off testing. The testing shall be fired from a 60mm M224 mortar at a convenient quadrant elevation. The mortar tube shall be instrumented with four (4) pairs of thermocouples located at the top and bottom of the gun at distances of 26, 27, 28 and 29 inches from the muzzle. The

test shall be fired as follows:

- a. Rapid fire phase - Two groups of thirty rounds each shall be fired at 30 rounds per minute on separate occasions.
- b. Sustained rate of fire phase - Two groups of two hundred rounds each shall be fired at 12-15 rounds on two separate occasions.

The barrel temperature shall be continuously monitored throughout the test. The actual rate of fire shall be determined by timing the firing sequence. The test shall be stopped if the weapon temperature exceeds the Designated Maximum Operating Temperature (D-MOT) of 538°C.

The ammunition cook-off test will utilize test rounds with inert fuzes and four (4) propelling charges but without the ignition cartridges. Using the same setup as above and following steps b. to obtain a tube temperature near D-MOT, the first test cartridge shall be inserted into the gun barrel. After the first round cooks off, additional test rounds shall be loaded into the barrel after each successive round cooks off. The process will continue until a round fails to cook off. The last round shall not be removed from the weapon for at least 30 minutes and until the tube temperature drops below 49°C (120°F).

The quantity of charges represented by the sample shall be rejected if:

- a. The peak tube temperature exceeds D-MOT during the rapid fire or sustained rate of fire testing.
- b. The tube temperature fails to reach equilibrium during sustained rate testing.
- c. The propelling charge ignites prior to reaching the firing pin of the mortar.

4.5.5.3.3 Interior ballistics. The test shall be conducted at a government proving ground in accordance with the applicable acceptance test procedure. The rounds shall be inert-loaded to an as fired weight of 3.75 +/- .01 pounds. The rounds shall be assembled at maximum charge (4 increments per rounds). Fifty rounds shall be conditioned to 70 +/- 2.5°F. Ten rounds each shall be conditioned to -50 + 5°F and 145 - 5°F respectively. The rounds shall be fired using a M224 - 60mm tube from a hard mount at an elevation of 800 mils. Calibration or reference rounds shall be fired one round per three test rounds for the 70°F group. Individual velocities, pressure and cartridge weight shall be recorded for each round fired. Velocity and pressure data shall be corrected to standard weapon/firing conditions. The mean velocity and velocity standard deviation shall be calculated. The lot shall be rejected if:

- a. The velocity standard deviation exceeds the requirement.

b. The k value in MIL-STD-1916 for variables inspection exceeds 2.49. The lower (L) and upper (U) specification limits shall be 770 and 820 fps respectively. The k value shall be calculated in accordance with paragraph 5.2.2.2.3 of MIL-STD-1914.

REJECTED

c. The mean pressure exceeds the requirement at 70°F or 145°F.

d. An individual pressure exceeds the maximum requirement.

e. An individual velocity is below the minimum requirement.

4.5.5.4 Flash/signature test. Video coverage of the firing tables testing (4.5.5.3.1) shall be used to evaluate the flash/signature of the M235 propelling charge. The M235 results shall be compared to the flash/signature of the M204 propelling charge. If the M235 flash/signature exceeds the M204, the quantity of cartridges represented by the sample shall be rejected. If the comparison is inconclusive, the test results shall be referred to the government technical agency for evaluation.

5. PACKAGING

5.1 Unit packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES (This section contains information of a general or explanatory nature which may be helpful but is not mandatory.)

6.1 Intended use. The M235 propelling charge is intended for use on 60mm mortar ammunition for the M224 Mortar System.

6.2 Acquisition requirements. Acquisition documents should specify:

- a. Title number and date of this specification.
- b. Interface dimensions for the mortar system, general HE physical characteristics and extractor.
- c. First article requirements.
- d. Design verification test schedule or test data submission.
- e. Design and configuration control requirements.
- f. Options to use alternate inspection and test methods.
- g. Propellant description sheets in accordance with MIL-STD-1171.
- h. Packaging requirements.
- i. Contractor responsibility for propellant preproduction requirements (if necessary) and propellant ballistic assessments.

6.3 Submission of inspection equipment design for approval. Submit copies of designs as required to : Commander, U.S. Army Armament, Research, Development and Engineering Center, ATTN: AMSTA-AR-QAA-C, Picatinny Arsenal, NJ 07806-5000. This address will be specified on the Contract Data Requirements, DD form 1423 in the contract.

6.4 Drawings. Drawings listed in Section 2 of this specification under the heading U.S. Army Armament, Research, Development and Engineering Center (ARDEC) may also include drawings prepared by, and identified as ARRADCOM, Edgewood Arsenal, Frankford Arsenal, Rock Island Arsenal or Picatinny Arsenal drawings. Technical data originally prepared by these activities is now under the cognizance of ARDEC.

6.5 Submission of alternate conformance provisions. All contractor proposed alternative conformance provisions will be submitted to the Government for evaluation/approval as directed by the contracting activity.

6.6 Propellant surveillance testing. A five pound sample of each propellant lot shall be forwarded to US Army Armament, Research, Development and Engineering Center (ARDEC), ATTN: AMSTA-AR-AEE-W, Picatinny Arsenal, NJ 07806-5000 for surveillance testing.

6.7 Subject term (key word listing).

Obturator
Static pressure
Stability
Primer sensitivity
Tube compatibility